DOCUMENT RESUME

ED 349 020 IR 054 128

AUTHOR Saylor, John M.
TITLE NEEDS (The National Engineering Education Delivery System): If We Build It (According to Standards) They Will Come!
PUB DATE 92
NOTE 19p.
PUB TYPE Reports - Descriptive (141)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Computer Networks; Computer Software; *Computer System Design; Cooperative Learning; *Curriculum Development; Delivery Systems; *Engineering Education; Federal Programs; Higher Education; Individualized Instruction; Information Retrieval; Learning Modules; Library Role; *Multimedia Instruction
IDENTIFIERS Learning Environments; *National Engineering Education Delivery System; National Research and Education Network; National Science Foundation

ABSTRACT

The National Science Foundation (NSF) is providing funds for coalitions of engineering educational institutions to improve the quality of undergraduate engineering education. A hypothesis that is being tested is that people can learn better in environments that allow self-paced and/or collaborative learning. The main tools for providing this environment are incorporated in what will be known as the National Engineering Education Delivery System (NEEDS). The NEEDS concept includes a fully networked distributed multimedia database for storing, searching, and retrieving this information, electronic classrooms for learning and teaching with the information, and authoring studios where the information is massaged into modules for instruction. These tools are initially being developed for use by students and instructors in engineering education. They will eventually be used by instructors and students at the opposite ends of the education spectrum, K-12 and continuing education. These multimedia modules will consist of the full range of graphical materials (interactive software modules, video segments, pictures and graphics, outlines and text). The recent federal commitment to the National Research and Education Network (NREN) will provide the networked electronic infrastructure on which to build NEEDS and help accomplish a major node in the vision of a Digital Library System. This report focuses on the activities of the Synthesis Coalition, one of four coalitions of universities involved in different aspects of the overall project. (BBM)

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NEEDS (The National Engineering Education Delivery System): If we build it (according to standards)they will come!

by John M. Saylor, Director, Engineering Library, Cornell University, Ithaca, NY 14853
e-mail: John_Saylor @qmrelay.mail.cornell.edu

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Summary and Introduction

The National Science Foundation (NSF) is providing funds for coalitions of engineering educational institutions to improve the quality of undergraduate engineering education. A hypothesis that we are testing is that people can learn better in environments that allow self-paced and/or collaborative learning. These environments need to provide information in a full range of formats including not only the traditional blackboard and lecture but also interactive software modules, video segments, pictures and graphics, outlines and text. The main tools for providing this environment are incorporated in what will be known as the National Engineering Education Delivery System (NEEDS). The NEEDS concept includes a fully networked distributed multimedia database for storing, searching, and retrieving this information, electronic classrooms for learning and teaching with the information, and authoring studios where the information is massaged into modules for instruction.

We are initially building these tools for use by students and instructors in engineering education. Eventually, these tools will be used by instructors and students at the other two ends of the education spectrum, K-12 and continuing education. The theory is that if we are successful in building effective tools, we will attract and retain a greater diversity and number of young students, especially women and underrepresented minorities, to the engineering profession. The recent federal commitment to the National Research and Education Network (NREN) will provide the networked electronic infrastructure on which to build NEEDS and help accomplish a major node in the vision of a Digital Library System.[2].

Project Goals

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Officially this project was born on September 30, 1990, when the NSF funded its first two Engineering Education Coalitions. The goals of the NSF program are: (1) to increase dramatically the quality of undergraduate engineering education as well as the number of engineering baccalaureate degrees awarded, especially to women and underrepresented minorities; (2) to design, implement, evaluate and disseminate new structures and fresh approaches affecting all aspects of undergraduate engineering education including both curriculum content and significant new instructional delivery systems; and (3) to create significant intellectual exchange and substantive resource linkages among major engineering baccalaureate-producing institutions and other major and smaller institutions.

NSF received 10 proposals, from teams involving 104 institutions. Initially, two groups of universities received funds of $15 million for five years -- the Synthesis Coalition(the subject of this paper) and the Engineering Coalition of Schools for Excellence in Education (ECSEL). The Synthesis Coalition schools are California State University at San Luis Obispo, the University of California at Berkeley, Cornell University, Hampton University, Iowa State University, Southern University, Stanford University, and Tuskegee University. This coalition represents diversity in geographical locations as well as variety in size, mission, and institutional type. In March of 1992, two more Coalitions were announced: the Gateway Coalition and SUCCEED (Southeastern University and College Coalition for Engineering Education).

For a more in depth introductory look at the first two Coalitions I recommend the following. The first is: "Synthesis: A Coalition Approach," by Robert J. Thomas, Professor of Electrical Engineering at Cornell University and Director of Cornell's Synthesis Coalition projects. (*ASEE PRISM*, pp.14-16, Preview Issue, 1991.) The second, which gives an introduction to the ECSEL Coalition is: "Engineering Coalitions Find Strength in Unity" by Jeff Meade. (*ASEE PRISM*, pp. 24-26. September, 1991). For more detail about curriculum reform activities in Synthesis, see "Refreshing curricula" by George Watson in *IEEE Spectrum*, March 1992, pp. 31-35(.

The major focus of this project is to restructure and provide tools for engineering education--not solely to support engineering research. The products of this work will be multimedia modules designed to enhance learning for all engineering students regardless of gender, ethnicity, or race. These multimedia modules will

consist of the full range of graphical materials (interactive software modules, video segments, pictures and graphics, outlines and text).[7]

What is Synthesis

The name Synthesis comes from the group's overall theme of interdisciplinary, multilevel (pre-college through postgraduate) integration of engineering knowledge, including design. This "synthesis" involves putting together a structure of individual parts (curricular reform, supporting technologies, recruitment and retention, and linkages) to make up a complex whole. (see Figure 1) The Curricular Reform component involves projects designed to revitalize the engineering curriculum both through innovative instructional modules and through systemic endeavors. Supporting Technologies contains projects that provide the supporting technology needed to accomplish this curricular change. Recruitment and retention (known in Synthesis parlance as Pipeline) refer to the need to attract and retain historically under-represented groups to engineering as a profession. Linkage refers to marketing methodologies used to promote the value and attractiveness of engineering as a profession beyond the traditional classroom to the public through high impact channels such as professional societies, television, and advertising. All Coalition projects (75 in all) are collaborative in nature, designed for dissemination to engineering schools throughout the country as well as K-12 levels.

7

Four Integrated Thrust Areas Will Produce These Deliverables

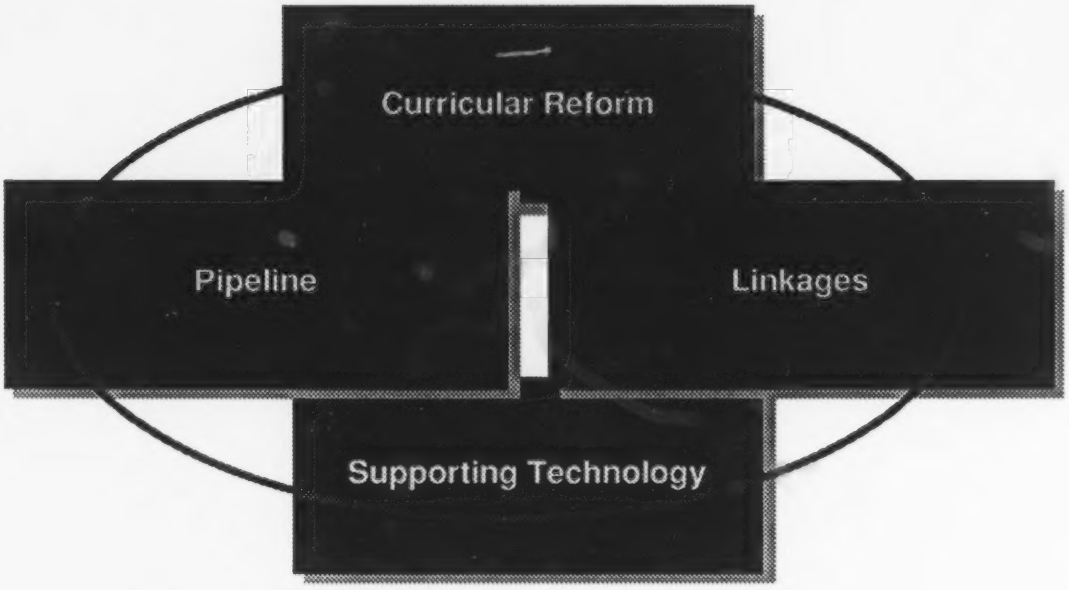


Figure 1.

Activities to Date

Curricular Reform Projects

Interdisciplinary Multimedia Case Studies

Case studies are prepared with computers and hypermedia. Students can navigate at their own speed, via workstations, through databases to learn not only scientific and technological background to the case study but also the social, historical, business, and environmental implications related to the case. One project that illustrates this idea is titled "Collaborative Design in a Networked Multimedia Environment." This project has recently been discussed in *EDUCOM Review* , Volume 27, number 1, 1992, pages 31-33, ("Collaborative Design in a Networked Multimedia Environment, " Gay, G.K... and Thomas, R.J..) and in *CD-ROM Professional*, Volume 5, Number 2, 1992, ("Joining Digital Hypermedia and Networking for Collaboration in Engineering

Design: a project's early consideration," Mazur, F.E. and Gay, G. K.). The design objectives of this project are twofold. First the learning environment is to be patterned after real-world employment. In industry, concurrent engineering (CE) principles are applied to solving design problems. Using LAN's and extensive networks, engineers work together with representatives of purchasing, marketing and others in the company during product design and review. CE is not very common in engineering education. As a result, graduates of engineering schools are not adequately prepared for working in this way when they are newly employed by industry. The second design objective is that contextual influences are to be emphasized. Critics from industry say that present day teaching is too simplified and frequently lacks depth of knowledge from other fields of study that relate to a problem. A key tool in testing these objects is the hypermedia database (NEEDS), which I will discuss later. According to the aforementioned article (Mazur and Gay) " The information nodes in the database are to be contextually rich and expressive in the presentation of content and are to reflect multiple representations so that students can better comprehend key engineering design concepts and principles."

Pipeline Projects

Beginners can learn design methodologies even though they lack background in engineering fundamentals. In this regard, freshman engineers are assigned simple but practical design projects to involve them in real world projects and keep their interest piqued from the beginning. One such course deals with spatial reasoning.

Linkage Projects -

The Curricular Reform, Supporting Technology and Pipeline thrusts support a multitude of strategically interrelated projects dedicated to improving the quality of undergraduate engineering education while increasing the participation of women and minorities. In contrast, the Linkage thrust is not project-based and focuses instead on *creating connections* with external "spheres of influence" that can potentially enhance and perhaps even expedite our reform efforts in the other thrust areas. In fostering an environment receptive to change, Linkage seeks to influence attitudes – attitudes supportive of math, science, and engineering; attitudes that reflect the need for technological literacy of all citizens; attitudes that reinforce the messages conveyed by our Coalition.

We are committed to ensuring that our efforts in curricular restructuring are not formulated in isolation – instead keeping engineering educators in the community colleges as well as our colleagues in K-12 informed and involved. Additionally, our NEEDS electronic network offers a tremendous opportunity to augment the human network effecting even more widespread adoption by linking our developments not only with one another but with the community colleges as well as K-12. And finally, we realize that comprehensive linkages that include entertainment, industry, and professional associations must play a major role in all that we are about, if we are ultimately to make a difference in engineering education in this country.

Supporting Technologies Projects

NEEDS

As mentioned above, a cornerstone of the project is the National Engineering Education Delivery System (NEEDS). NEEDS consists of: (a) multimedia databases of curricular materials consisting of data elements ranging from simple text to full motion video, which are connected to; (b) courseware development studios for faculty and; (c)high-technology classrooms connected through high speed networks, both on campus and internationally through the NREN. (See Figure 2) In NEEDS we are building a major node in the networked Digital Library System.

The National Engineering Education Delivery System: NEEDS

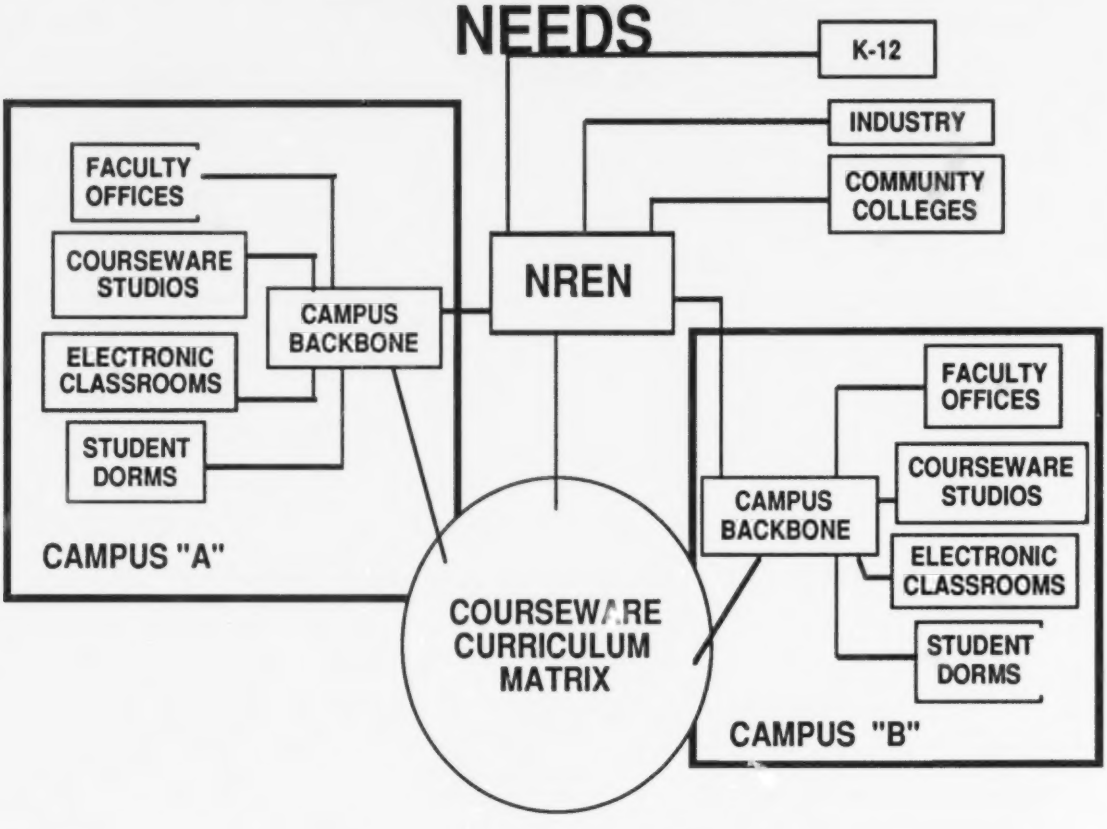


Figure 2

Standards Study Project (SSP)

The Standards Study Project is a separately funded, five year project whose purpose is to identify the technologies required for NEEDS; to identify the problem areas due to lack of standards in information storage, retrieval, transfer and manipulation; to identify the existing and developing relevant standards; and to suggest effective courses of action to allow NEEDS to develop in concert with emerging standards and technologies. We have convened a Standards Study Advisory Group of experts from industry and academe and have held three national meetings to date. I described the

first two of these meetings in more depth in the premier issue of the electronic publication *Issues In Science And Technology Librarianship*, (December 1991.)

Accomplishments of NEEDS and SSP

The Standards Study Project has evolved to become the leading force in Synthesis in planning and developing NEEDS. Planning the architecture of the database, electronic classrooms, and courseware studios has been the focus of our first two major meetings.

SUPPORTING TECHNOLOGY/ STANDARDS

Supporting Technology

- Develop NEEDS components
- Coordinate and evaluate NEEDS projects:
  - + Networking/ Communications
  - + Courseware Development
  - + Database Elements
  - + Classroom Capability
- Request Equipment

Standards

- Identify technologies applicable and required by NEEDS
- Identify elements of the National Database:
  - + Methods of information storage, retrieval, and transfer
  - + Methods of high speed data transfer among Universities
- Communicate information

Meeting of October 1991

The Standards Study Project Advisory group is made up of Synthesis Coalition members, industrial partners, the Interactive Multimedia Association, and other

interested volunteers . This group divided into three committees based on the database standards, the electronic classroom , and the courseware studio. In this first meeting the DataBase Standards Committee recommendations were to: (1) set up a coalition-wide editorial board to deal with policy and planning for the NEEDS database; (2) more precisely define access control requirements for the NEEDS repository; (3) define in detail the functional requirements for the institutional NEEDs servers and differentiate the functions of the central repository and the institutional systems more precisely.

We defined a preliminary two part architecture for the central NEEDS database. The first part would be a repository of source material. The second part would be a catalog of MARC-like records describing the source material. The central NEEDS database would be a repository of the full spectrum of source material (simple text to multimedia modules) and be accessible via the internet. The database would be built on the MARC record and would support the Z39.50 Search and Retrieval protocol.

One of the goals of this group is to provide a more formal vision of the overall system architecture of the database for the coalition to react to and discuss.

The NEEDS Standards Advisory Group recommended that a prototype delivery system be implemented according to the following guidelines:

1 - ***NEEDS*** *must appear to users as a unified library of courseware modules and data elements for building courseware.* NEEDS will actually consist of specialized public and private databases distributed around the world; even so, it must appear to be a **simple, unified system.**

2 - The ***NEEDS catalog*** *must be available to users with* ***minimal hardware, software, and expertise.*** The first version must have a simple, text oriented interface that requires only ubiquitous hardware and public domain or common communication software so we need not distribute or maintain software nor train people in its use. A more elaborate base of hardware and software may be needed to browse the material. A graphics oriented interface (probably built on X-Windows) will be introduced as a later step.

3 - **NEEDS** will be built on a base of communication and networking standards such as **TCP/IP** (evolving to **OSI**) used over the **Internet** (evolving to the **NREN**). We will make use of open standards communication software such as **Telnet** and **FTP** whenever it is practical to minimize our programming and maintenance burdens. Close attention will be paid to centralizing and minimizing maintenance needs as a general strategy.

4 - **NEEDS** will follow the **Library model** in which a catalog is used to find an object (courseware module, graphic images, etc.) of interest. The user will then enter a simple command to start an immediate electronic (or physical in the cases of video cassettes or CD/ROM) transfer of the object from its owner. Access to the catalog will be free and open to all, although acquisition of some objects listed in the catalog may be controlled by particular owners.

The catalog/object model has many advantages: it allows for the actual location of objects to be moved without changing the catalog; acquisition controls and charges can be directly between the user and the owner of the data object---the NEEDS manager need not be the person in the middle, enforcing someone else's rules; another important aspect of the catalog/object model is that the objects described in the catalog can be of any type or language, etc. just as a normal catalog entry can identify a book written in classical Greek or a 78 RPM record. Thus we need not arbitrarily limit the data types which are permitted in NEEDS, thereby allowing for its easy evolution.

5 - Library cataloging standards and practices will be used from the outset. This strategy will insure transportability between diverse catalog systems and greatly simplify the transition to multimedia based catalog systems such as VTLS when they become available. USMARC rules for cataloging computer data files have been developed by many experts working for many years; it is only prudent to take advantage of that accumulated expertise by adhering to those rules and enlisting the support of library cataloging experts in our endeavor.

6 - **NEEDS** should be integrated with an existing university **On Line Catalog** or Catalogs to make use of the robust, powerful search engines associated with them. This strategy looks forward to a future in which library professionals consider NEEDS to be an important part of their mission to connect the public with high quality

information. The long term viability of NEEDS will surely be enhanced if a major university library assumes part of the responsibility for it. Integration into an existing on line catalog also insures that most users will already be familiar with how to use the catalog; the few who need help can obtain it from library user support personnel and documentation thereby relieving the Coalition of a significant training and user support responsibility.

Work Accomplished Since October '91

A NEEDS prototype, which followed the guidelines set forth above, was developed at Iowa State University in cooperation with the Iowa State University Parks Library. It was successfully demonstrated at the Standards Study meeting held at Cornell University on March 19-20, 1992. In the demonstration, an operator accessed a **NEEDS SERVER** which transparently connected to the on line catalog at the Parks library. A *bona fide* courseware module was located in the catalog using the library's unmodified search engine; the operator entered the command 'get' and the data file was sent from yet another remote computer to a computer at Cornell. The computer to which the data file was delivered demanded that the operator verify himself before it would permit the transaction to be completed. Figure 3 is an example of the course module as cataloged in the Iowa State OPAC.

COMPUTER FILE - Record 1 of 1 Entry Found Long View

---------- + Screen 1 of 3 ----------FD02

Title: Rene Descartes

Author: Hiemcke Christoph , Iowa State University, Ames, IA 50011

Edition: Version 1.0 . NEEDS-01-01-0001

Publisher: National Engineering Education Coalition, Feb. 1 , 1992

Description: SuperCard run-time file

System Req.: Macintosh II, 8M RAM, Color, System 7, SuperCard Software

Notes: No licensing, Created with SuperCard and SoundEdit, 2645K bytes

FORMAT: SuperCard TYPES: text, image, audio CONTENTS: image

---------- Continued on next screen –

COMMANDS: BR Brief View H Help

F Forward

O Other Options I Index

Figure 3

DATABASE ADVISORY GROUP RECOMMENDATIONS 3/20/92

•The NEEDS DataBase Standards Advisory Group in attendance reaffirmed the guidelines set forth earlier.

•The group had extensive discussions concerning provisions for incorporating copyright and other property rights information in the cataloging records. Emphasis was also placed on ensuring that licensing arrangements be made between well identified entities when such arrangements are necessary.

•The functions of the **NEEDS SERVER (see figure 4)** were discussed and it was decided that its functions should include:

a)-providing a transparent connection between users and on line catalogs as well as to other data sources,

b)-initiating the transfer of data files from owners to users, and

c) -keeping simple statistics including the number of times the transfer of a particular data file is initiated but excluding any personal information such as user names and passwords.

d)-The NEEDS Server will also assist users in locating developmental multimedia databases of courseware and data elements.

•The group recommended:

a) that NEEDS COORDINATORS be identified; one at the national level (existing) and one at each campus; The duties of the National NEEDS Coordinator will include receiving, validating, archiving and assigning unique identifying numbers to data being entered into any of the NEEDS databases, coordinating with managers of the NEEDS databases, keeping administrative records, and working with the campus coordinators. The campus coordinators will work with courseware authors and others to validate software, transfer it to a NEEDS database server, and to develop draft cataloging records based on MARC cataloging rules; the coordinator will work with library catalogers and other library personnel to enter the catalog record into the on line catalog.

b)that **funded formal arrangements** be established with a university library or libraries to provide cataloging support and to establish a NEEDS ON LINE CATALOG.

•Computers must be identified or acquired to serve as (1) the NEEDS SERVER on which the catalog access program resides and (2) a stable location to store NEEDS data files at the institutional level.

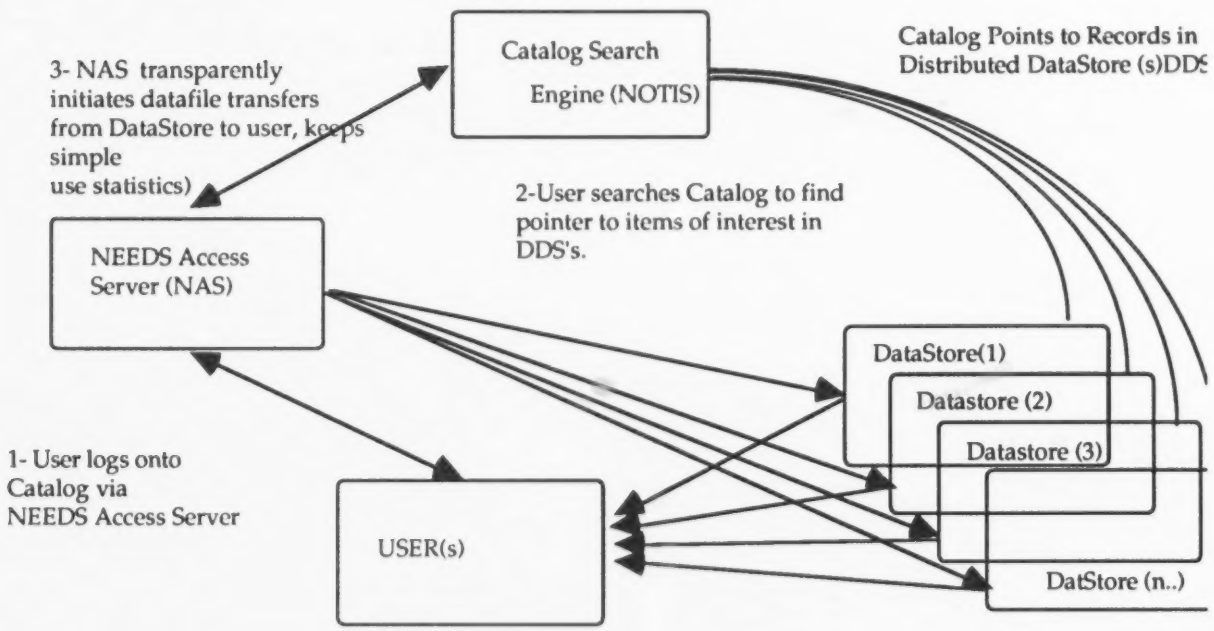
•We further recommend that the Standards Study Project be charged with the library collection development and acquisitions responsibility of soliciting and otherwise locating data elements and courseware modules suitable for incorporation into NEEDS and to aggressively pursue building the size of NEEDS as rapidly as is practical while maintaining quality.

We propose that the National Engineering Education Delivery System, NEEDS, be constituted as outlined above and that the executive board of the Synthesis Coalition affirm that fact.

QUESTIONS TO BE ADDRESSED

1. Who can submit material to NEEDS?
2. Who decides on what goes in?
3. Will licensed materials (copyrighted) reside inside or outside of the database.?
4. Who in the coalition is authorized to make licensing agreements and with who?
5 Do we need to accept the fact that database content will be platform specific?

Figure 4. NEEDS Architecture- Search and Retrieval



Difficulties Encountered

• There is a great volume of material being produced with no way to organize it
Currently there are Synthesis Coalition courses being taught and designed. A vast quantity of graphical materials such as slides, video segments, graphics are being produced but no database exists as yet in which to store this material. This is happening on a large scale.

• How to make this material available to and usable by others
There has been no firm commitment or plan on how this material will be cataloged or indexed.

• Lack of adopted Multimedia Standards

Content material (slides, video, etc) are being stored two ways: compressed in Quicktime (not an industry standard) and as uncompressed images in order to provide access for use by those with differing equipment resources.

•Tenure Issues
Tenure is largely based on research publication. Production of materials for undergraduate education is not currently mainstreamed in the reward structure for scholarly promotion

•Time involved in creation of multimedia materials
Will already overburdened faculty and staff take the time to learn new techniques and skills to create and perform in the multimedia environment?

•Intellectual Property Rights issues
This is really the dam that is holding back the flood of availability and use of electronic multimedia information. It is one of the two major impediments to the large scale conversion of paper collections to electronic form, the other being cost. ((8)LYNCH, 1991)

Questions to be Answered

Do we collect in db everything being produced?
At this point the scenario is that when a project produces a deliverable that the investigator is happy with, we will store it.

If not, who reviews what goes in?

The review board issue has not been resolved.

We will build what we can afford or are given

At this point it is felt that we have (or will have)unlimited storage so we will probably store everything produced by the Synthesis projects. It is believed by some that in the near future, "Malthusisan concerns about data overpopulation are easily solved by a combination of advances in high density storage systems and techniques which allow data to die a natural death. (Kahn, Robert E & Cerf, Vinton G. , The Digital Library Project Volume 1: The World of Knowbots (Draft). Corporation for National Research Initiatives, 1988, page 10)

Library's role

The business of libraries is to select, organize, preserve, and provide access to information. The business of managing multimedia education databases in this way brings up many issues and unanswered questions.

Finding Relevant Material

"Finding relevant material, and even learning of its existence, is often a massive challenge. This problem is not unique to the research world domain. It plagues virtually every information-dependent human endeavor." - (Kahn, Robert E & Cerf, Vinton G. , The Digital Library Project Volume 1: The World of Knowbots (Draft). Corporation for National Research Initiatives, 1988, page 14)

Selecting Material

Does our role in the Digital Library System diminish in terms of selecting materials? Who will decided what goes into the multimedia educational database?

Preserving Material

What role do we play in preserving electronic, multimedia, educational material? What new infrastructure and expertise do we have to develop in order to archive this material. Preservation in the electronic environment is potentially easier than in the paper environment. What we must accomplish and maintain is to obtain an institutional commitment to "refreshing" our digital databases as technology evolves.

Providing Access

Providing access to multimedia objects via electronic networks is currently the subject of much research. The only off-the-shelf library software currently available (that I know of) to handle this is provided by VTLS Inc. in their VTLS InfoStation front end to their integrated multimedia OPAC system. The problem with

VTLS at this point is that it only runs on the proprietary NeXT hardware and software. (LEE)

Conclusion

The business of education is to create, transmit, store, retrieve, display, manipulate, and interact with information

The business of libraries is to select, organize, preserve, and provide access to information.

Computers and their networks are tools used to facilitate these activities.

Ones judgement cannot be better than the information upon which it is based. Given the truth, one may still go wrong when one has the chance to be right. But not given news or presented only with distorted and incomplete data, you destroy the whole reasoning process... from Arthur Hays Sulzberger , address, NYS Publishers Association (8/30/48)

NEEDS is a crucial tool that the engineering educators in Synthesis will rely on in their business of educational reform. Librarians will assist in the process of building NEEDS based on their long term experience and knowledge of selecting, organizing, preserving, and providing access to information. Network computers and their associated databases of information and applications for manipulation will provide the tools for facilitating the work. This is truly a collaborative project.

References

1) Watson, George F. (1992) "Refreshing Curricula", IEEE Spectrum, vol , no. March, pages 31-35

2) Kahn, Robert E & Cerf, Vinton G.(1988) , The Digital Library Project Volume 1: The World of Knowbots (Draft). Corporation for National Research Initiatives

3) Thomas, Robert J, (1991) "Synthesis: A Coalition Approach," *ASEE PRISM*, pp.14-16, Preview Issue, 1991.)

4)Meade, Jeff "Engineering Coalitions Find Strength in Unity" *ASEE PRISM*, pp. 24-26. September, 1991

5)Gay, G.K. and Thomas, R.J. (1992) "Collaborative Design in a Networked Multimedia Environment." *EDUCOM Review* , Volume 27, number 1, 1992, pages 31-33,

6) Mazur, F.E. and Gay, G. K. (1992)"Joining Digital Hypermedia and Networking for Collaboration in Engineering Design: a project's early consideration," *CD-ROM Professional*, Volume 5, Number 2, 1992,

7) Lynch, Clifford, A. (1991) " The Technologies of Electronic Imaging," *Journal of the American Society for Information Science*, 42(8):578-585

8.) Lynch, Clifford A. (1991) " The Development of Electronic Publishing and Digital," *Electronic Networking*, 1(2):6-22

9.) Saylor, John M. (1991), " NEEDS: The National Engineering Education Delivery System", *Issues in Science and Technology Librarianship*, a publication of the Science and Technology Section, of the Division of the Association of College and Research Libraries or ALA. ACRLSTS@HAL.UNM.EDU, Centennial Science and Engineering Library, University of New Mexico, Albuquerque, NM 87131